

Mediastinal Emphysema

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SINCE IT USUALLY IS CONCOMITANT with pneumothorax or subcutaneous emphysema, mediastinal emphysema rarely gets more than perfunctory attention. The development of severe subcutaneous emphysema without the coexistence of pneumothorax may turn the mind of the observer to conjecture as to the mechanisms by which the condition came about. The occasional occurrence of subcutaneous emphysema during coughing attacks, asthmatic attacks, parturition, operative procedures, bronchoscopy and esophagoscopy, or spontaneously, may perplex the patient and the physician.

In 1944 Macklin and Macklin⁸ published a detailed report on "Malignant Interstitial Emphysema of the Lungs and Mediastinum as an Important Occult Complication in Many Respiratory Diseases and Other Conditions." From their studies, both clinical and experimental, they found that a rapid decrease in intrathoracic pressure caused rupture of the perivascular pulmonary alveoli. This permitted the development of interstitial emphysema of the lung and, with migration of the air toward the hilum of the lung, mediastinal emphysema. The air within the interstitial tissues of the lung can also migrate beneath the visceral pleura and form blebs, which may rupture, giving rise to pneumothorax.

The air within the mediastinum may rupture through the mediastinal pleura, causing pneumothorax, it may migrate cephalad, causing subcutaneous emphysema or it may migrate caudad, causing pneumoperitoneum. Air in the anterior mediastinum gives rise to a loud crunching sound, Hamman's sign, with each heart beat.⁶

Clinically, mediastinal emphysema is not ordinarily of much importance because the mediastinal or visceral pleura usually ruptures and the air is released from the mediastinum into the pleural cavity. This was shown very well by the recent work of Webb, Johnston, and Geisler.¹⁴ Experimenting with rabbits and dogs, and with humans at the autopsy table, they introduced air into the mediastinum and observed that the result was first mediastinal emphysema, then movement of the air along the fascial planes to bring about pneumothorax. "At no time were we able to develop a persistent pressure within the normal mediastinum greater than about 5 mm. Hg," they said, concluding

• Mediastinal emphysema may occur due to migration of air from the lungs, from the esophagus or tracheobronchial tree and from the abdomen. Of especial interest is the mechanism starting with the rupture of the perivascular alveoli due to a rapid decrease in intrathoracic pressure from any cause, the development of pulmonary interstitial emphysema and migration of the air into the mediastinum.

In one case the patient had severe interstitial emphysema of the left lung, mediastinal emphysema and subcutaneous emphysema without pneumothorax and rapid improvement followed tracheotomy.

In another case the patient had interstitial emphysema of the left lung that did not progress to mediastinal emphysema and subcutaneous emphysema. Pneumothorax was not present. Recovery was more rapid than in the first patient.

ing that mediastinal emphysema must rarely cause symptoms and that whatever symptoms do occur are probably owing to associated pneumothorax. They also emphasized that the mediastinal emphysema they studied is completely different from that which is a concomitant of interstitial emphysema of the lungs. The pneumothorax is treated by inserting a tube into the pleural cavity and carrying out underwater seal drainage, thus relieving the pressure. If the mediastinal or visceral pleura does not rupture, however, the continued accumulation of air within the mediastinum may cause a high intramediastinal pressure to build up and obstruct the flow of blood from the lungs to the heart. In this situation great relief may result from a cervical incision and tracheotomy.^{10,11}

Air may enter the mediastinum in several ways:

1. Any occurrence which can cause rupture of the perivascular pulmonary alveoli—such as coughing, straining at stool or parturition, trauma in an automobile collision—or spontaneous rupture can give rise to interstitial emphysema and its sequelae, mediastinal emphysema and subcutaneous emphysema with or without pneumothorax.

2. Perforation of the trachea, bronchi or esophagus due to foreign body, instrumentation, ulceration or trauma.

3. Operations in the neck, especially in association with tracheotomy or thyroidectomy. The exact mechanism of occurrence of mediastinal emphysema in association with these operations is somewhat controversial.¹² Does the air enter through the incision—that is, is it aspirated from above, or does

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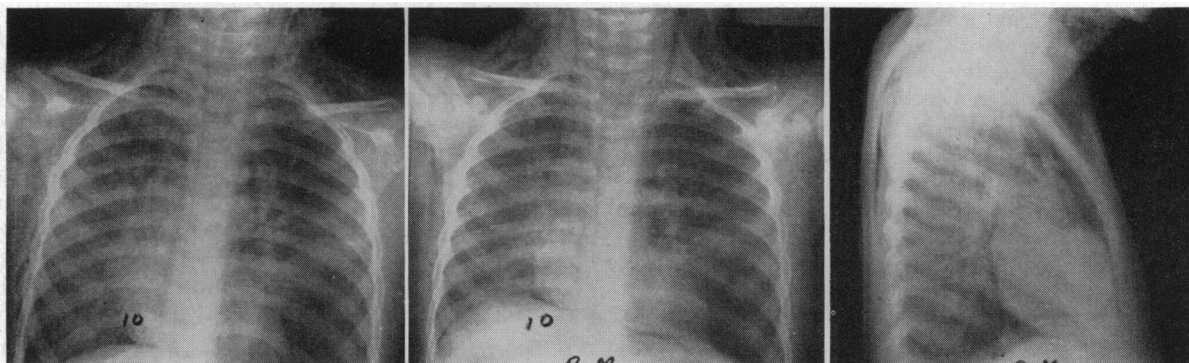


Figure 1 (Case 1).—X-ray films taken on admission to the hospital. *Left:* Film taken after inspiration shows an infiltrate in the left mid-lung field, hyperaeration of the left lung and subcutaneous emphysema. *Center:* Film taken after expiration accentuates the conditions and shows that the left lung does not deflate as well as the right. *Right:* Lateral view shows the presence of mediastinal and subcutaneous emphysema.

it arise as a sequel of rupture of some perivascular pulmonary alveoli? Conditions causing obstruction of the airway frequently produce great respiratory efforts which may rupture the perivascular alveoli and permit the development of interstitial emphysema of the lung and thus mediastinal emphysema.

4. Perforation of a hollow abdominal viscus. Several instances of mediastinal emphysema resulting from a perforated peptic ulcer have been reported.

5. Air may be deliberately introduced into the mediastinum for diagnostic purposes.

6. Pneumomediastinum has occurred during the therapeutic administration of pneumothorax or pneumoperitoneum.

It has been recognized for some time that interstitial emphysema is more common during infancy and childhood.¹ In 1956 Emery,⁴ reporting on autopsy of 14 newborn infants who had interstitial emphysema, stated: "The immediate cause of death in all these infants was air in the pleural cavity and mediastinum with apparent compression of the vessels at the roots of the lungs, producing 'air-block.' The interstitial emphysema in all cases appeared to be due to mucus, with amniotic debris and vernix, causing differing degrees of obstruction in the smaller air-passages of the lungs." Berman² reported the case of a normal newborn infant in whom progressive respiratory difficulty and cyanosis developed at 18 hours of age. X-ray films of the chest showed a shift of the mediastinum to the right and atelectasis of the right upper lobe, which was interpreted as being due to lobar emphysema or pneumatocele of the left lung. At left thoracotomy done when the infant was 30 hours old, a left marginal pneumothorax and a mediastinum which contained large bubbles of air was observed. No other abnormality was noted. The mediastinum was opened and the patient recovered, being discharged on the eighth postoperative day.

REPORTS OF CASES

CASE 1. A 28-month-old white girl was brought to the hospital by her parents on February 11, 1958, because of "swollen head and neck." The patient had had a croupy cough for one week and for two days had had grunting respirations, anorexia, headache and pain in the eyes. When, three days before admittance to hospital, the temperature had risen to 103° F., Terramycin (oxytetracycline), was administered, 125 mg. three times a day. The fever persisted and on the day of admittance a physician had given the child an injection of penicillin. After returning home from the physician's office the parents noted swelling of the child's face and neck and, attributing it to penicillin reaction, took her to the hospital.

The patient had had pneumonia at one year of age and no other illnesses. Two siblings had had upper respiratory infections recently.

Upon physical examination the face was noted to be decidedly swollen due to subcutaneous emphysema, the eye-lids so thickened that they were closed. The neck was greatly swollen due to subcutaneous emphysema, and subcutaneous emphysema was also palpable over the upper part of the chest anteriorly and posteriorly. Breath sounds were loud and harsh over the right lung but absent over the left. No definite rales were heard. Breathing was rapid and shallow. The heart rate was rapid, the rhythm regular. No murmurs were heard.

Upon urinalysis, the reaction for acetone was strongly positive. Hemoglobin content of the blood was 9.0 gm. per 100 cc. Leukocytes numbered 8,100 per cu. mm.—69 per cent polymorphonuclear cells, 30 per cent lymphocytes and 1 per cent monocytes.

X-ray films of the chest were interpreted as showing obstructive emphysema of the left lung with mediastinal and subcutaneous emphysema. Also there was an area of infiltration in the left mid-lung field (Figure 1).

The rectal temperature at the time of admittance was 101° F. Breath sounds could not be heard over the left lung. The roentgenologist considered rupture of the esophagus or bronchus. A small swallow

of barium outlined a normal esophagus. Penicillin, 600,000 units every 12 hours, and tetracycline, 125 mg. four times a day, were administered and the patient was placed in a croup tent.

Next day the swelling of the face, neck and upper chest was more pronounced. Respirations were rapid and labored. Swelling of the subglottic area appeared to obstruct the respirations. X-ray films showed obstructive emphysema of the left lung and an increase in the mediastinal and subcutaneous emphysema.

Obstructive emphysema of the left lung due to a foreign body in the left main stem bronchus with interstitial emphysema of the left lung, mediastinal and subcutaneous emphysema were considered as the probable sequence of events.

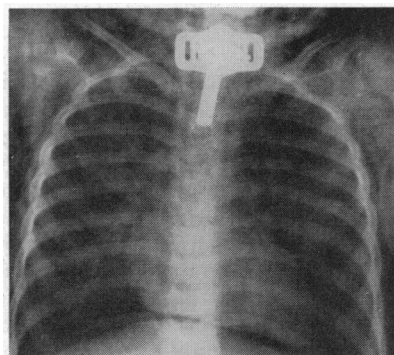


Figure 2 (Case 1). — Film of chest taken after bronchoscopy and tracheotomy shows tube in place, lungs of equal size and the mediastinum in the mid-line.

Accordingly, bronchoscopic examination was performed under general anesthesia. Tracheobronchial aspirate obtained at bronchoscopy was cultured for bacteria and later reported to show no growth. No foreign body was found. Due to the respiratory distress and the severe swelling of the neck caused by the subcutaneous emphysema, tracheotomy was performed. When the transverse cervical incision was made, air gushed out of the tissues, indicating that considerable pressure had accumulated in the mediastinum. A postoperative x-ray film (Figure 2) showed apparent improvement in the lungs.

The temperature rose to 103.3° F. rectally after bronchoscopy.

On the second day in the hospital the rectal temperature declined to 100.8° F. X-ray films showed overdistention and rigidity of the left lung. Breath sounds over the left lung still were absent. The patient was breathing easier through the tracheotomy tube.

On the third day the clinical condition of the patient improved although no change was observed in x-ray films of the chest and breath sounds still were absent over the left lung.

On the seventh hospital day the tracheotomy tube was removed. X-ray films (Figure 3) showed rigidity and overdistention of the left lung. Subcutaneous emphysema was decidedly decreased. On the thirteenth day the patient was clinically well but breath

Figure 3 (Case 1).—Six days after bronchoscopy and after removal of tracheotomy tube. *Left*: Film taken after inspiration shows overdistention and hyperaeration of the left lung. The left mid-lung infiltrate is still present. Note pronounced decrease in subcutaneous emphysema. *Right*: Film taken after expiration shows that the left lung is rigid and does not collapse. There is a shift of the mediastinum to the right.

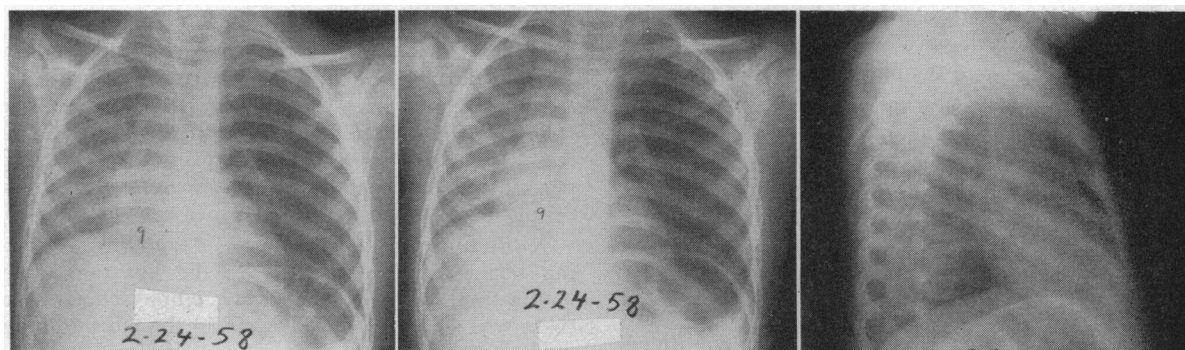
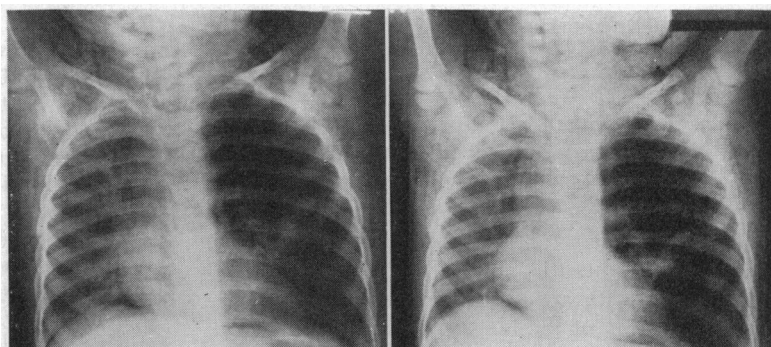


Figure 4 (Case 1).—Films taken twelve days after bronchoscopy. Note complete disappearance of the mediastinal and subcutaneous emphysema. (Breath sounds over the left lung still absent.) *Left*: Film after inspiration shows left lung still slightly hyperaerated and enlarged. *Center*: Film taken after expiration accentuates rigidity of left lung and shift of mediastinum to the right. *Right*: Lateral film shows that the mediastinal and subcutaneous air has now been absorbed.

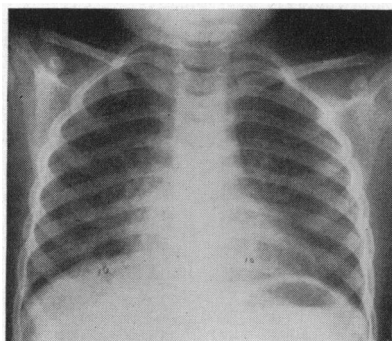


Figure 5 (Case 1).—Lungs normal 19 days after bronchoscopy. (Breath sounds over the left lung were clearly heard.)

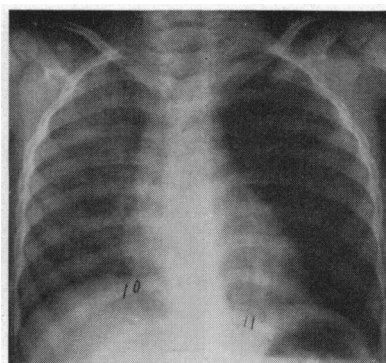


Figure 7 (Case 2).—Film taken on third hospital day shows hyperaeration of the left lung. (Breath sounds over left lung had returned and there was very little mediastinal swing on expiration.)

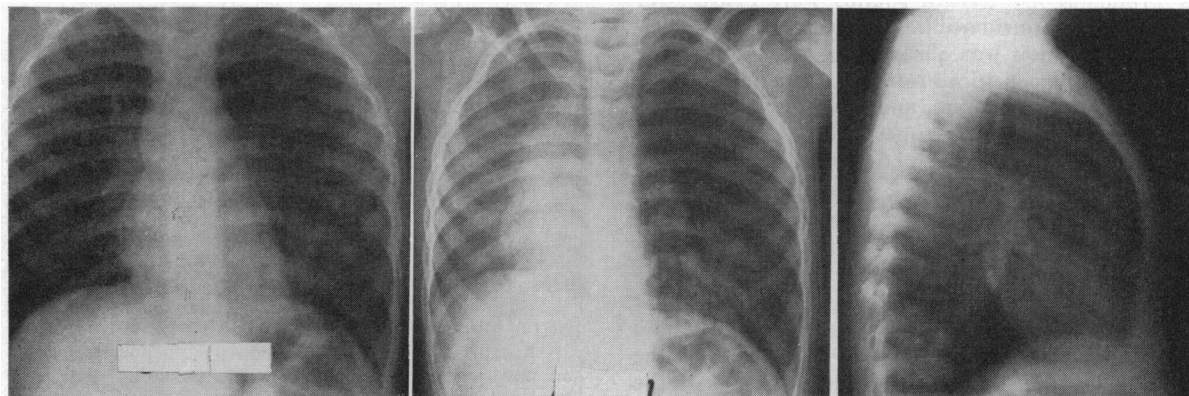


Figure 6 (Case 2).—Films taken on admission show obstructive emphysema of the left lung. (Breath sounds were absent over the left lung.) *Left:* Film taken after inspiration shows some hyperaeration of the left lung. *Center:* Film taken after expiration shows no collapse of left lung and decided swing of the mediastinum to the right. *Right:* Lateral film shows some increase in the anterior-posterior diameter of the chest.

sounds still were absent over the left lung. X-ray films (Figure 4) showed improvement but the left lung was still hyperaerated and did not deflate properly. Not until three weeks after the patient entered the hospital did breath sounds over the left lung become clearly audible. No abnormality was seen in an x-ray film of the chest (Figure 5). Last seen 14 month later, the patient was well and was developing normally. No abnormality was seen in x-ray films of the chest.

Comment. As no definite obstruction of the left main stem bronchus could be demonstrated, it is probable that the sequence of events in this patient was as follows: The severe coughing caused rupture of perivascular alveoli, which permitted the escape of air into the interstitial tissues of the lung, the lung becoming rigid owing to extensive interstitial emphysema, hence not transmitting breath sounds. Then gravitation of air from the left lung along the pulmonary blood vessels toward the hilum of the lung resulted in mediastinal emphysema and then subcutaneous emphysema. Pneumothorax did not occur. Resolution of the subcutaneous and mediastinal emphysema proceeded rapidly but resolution of the pulmonary interstitial emphysema took some time.

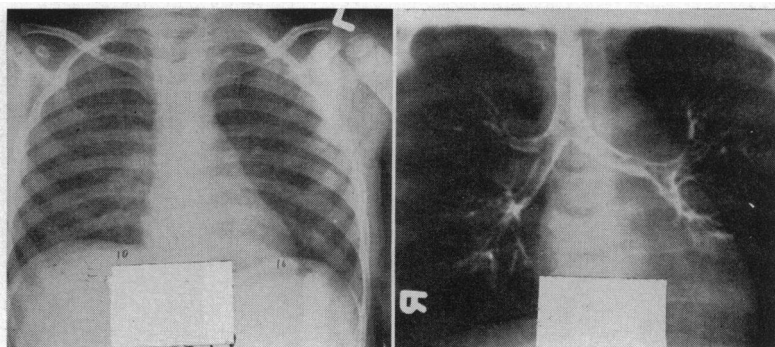
CASE 2. A 2-year-old slightly underdeveloped white girl was brought to the hospital February 23, 1958, by her foster mother because of chronic cough and loss of weight. About a month and a half previously the child had partially choked while eating almonds. Since then she had had a chronic cough. She had not eaten well and, questioning indicated, may have had some fever. No information as to past history was obtainable.

The patient was small and thin. She was alert and did not seem acutely ill. The pulse rate was 140, respirations 46 per minute and the rectal temperature 100.6° F. Except for absence of breath sounds over the left lung, no abnormalities were noted in the remainder of the physical examination. The hemoglobin content of the blood was 11.8 gm. per 100 cc. Leukocytes numbered 33,800 per cu. mm., 84 per cent polymorphonuclear cells, 8 per cent lymphocytes, 7 per cent monocytes and 1 per cent basophiles.

In x-ray films (Figure 6) of the chest, hyperaeration and rigidity of the left lung were noted. The mediastinum shifted to the right on expiration. These changes were compatible with foreign body obstruction of the left main stem bronchus.

Bronchoscopic examination was performed three days after admittance. No foreign body was seen, but a small amount of mucus was aspirated. Follow-

Figure 8 (Case 2).—*Left:* Lungs normal after seven days' hospitalization. (The patient was clinically well.) *Right:* Bronchogram taken on sixteenth hospital day, showing normal tracheobronchial tree.



ing bronchoscopy, breath sounds were heard over the left lung. Considerable improvement in the pulmonary condition was observed in x-ray films. The patient was placed in a croup tent. Penicillin, 600,000 units every 12 hours, and oxytetracycline (Terramycin), 125 mg. four times a day, were administered. From then on the patient was afebrile.

On the fourth hospital day x-ray films showed the left lung was still hyperaerated and did not deflate as well as the right (Figure 7) but breath sounds were heard over it. X-ray films on the sixth day and again on the eighth showed no abnormality either on inspiration or expiration (Figure 8), and breath sounds over both lungs were normal. On the sixteenth hospital day, bronchograms taken with the patient under general anesthesia showed no abnormality. When last seen some two months later, she was progressing normally.

Comment. Here, as in case 1, a child with a severe cough developed evidence of partial obstruction of the left main stem bronchus. The left lung was enlarged and rigid and did not transmit breath sounds. Bronchoscopic examination on the third day of hospitalization did not reveal any definite obstruction of the left main stem bronchus. Although breath sounds were heard over the left lung on the third day of hospitalization, it took about five days for the lung to return to normal roentgenographically. It is assumed that, due to severe coughing, interstitial emphysema of the left lung developed but did not progress to appreciable mediastinal emphysema.

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